Geophysical Research Abstracts, Vol. 7, 10125, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10125

Parametric Subharmonic Instability and the Bispectrum of the Ocean Internal Tide

E. Frajka Williams (1), E. Kunze (2), J. MacKinnon (3), K. Winters (3)

(1) University of Oceanography, (2) University of Victoria, (3) Scripps Institution of Oceanography

Once touted as a primary mechanism for nonlinear transfer of energy in the ocean internal wave spectrum, evidence was not forthcoming and parametric subharmonic instability (PSI) was later disqualified due to slow theoretical timescales of interaction. The timescales, however, were based on a random phase approximation of the internal wave spectrum, which is invalid in the case of a coherent internal tide. Accordingly, PSI again finds itself a contender for the transfer of internal wave energy to smaller vertical scales. PSI is a nonlinear resonant wave-triad interaction in which a parent wave transfers energy to two daughter waves with frequency near half the initial frequency and higher vertical wavenumbers. As such, it would be an intermediary mechanism for the cascade of energy to turbulence scales. In this paper, we demonstrate its efficacy at transferring energy through the use of a fully-nonlinear, nonhydrostatic Boussinesq model and the bispectrum.

Using the resonance conditions and dispersion relation for an M_2 internal tide, the locus of available PSI wavenumber triads is determined as a function of the parent wave frequency and wavenumber, latitude and daughter wave frequency. Then the energy equations are demonstrated to transform in such a way that nonlinear terms become precisely the third-moment spectral quantity, the bispectrum. This statistical tool is then applied to a model run of a mode-1 M_2 internal tide demonstrating that the expected locus of triads are activated. Through further investigation, the transfer of energy through the vertical wavenumber spectrum is quantified, the relevant nonlinear terms identified, and their physics explained. Based on these, and application of the bispectrum to ocean velocity data near the Hawaiian Ocean Ridge, recommendations are made for further field observations of this interaction. Our hope is that this paper will provide a useful starting point for future experiments looking for PSI in the wild.